

Described from two females collected at Hyattsville, Maryland, June 4, 1913. Type a female deposited in U. S. National Museum, Washington, D. C. A figure of the abdomen of *Celatoria diabrotica* has been provided for the purpose of comparison (plate I, fig. 3).

NOTES ON THE ENTOMOLOGY OF THE ARIZONA WILD COTTON.

BY W. D. PIERCE AND A. W. MORRILL.

Arizona wild cotton, *Thurberia thespesioides*, has been under observation for several years, by Prof. J. J. Thornber, of the University of Arizona, who has acquired specimens from many different localities in southern Arizona and has in fact recommended it as a flowering shrub. Possibly it first received attention from an entomological standpoint from one of us (Morrill), when, in August, 1912, in company with Prof. R. H. Forbes, director of the Arizona Experiment Station, several plants were found and examined near Fish Creek on the Roosevelt Road, where the plant had not previously been known to exist. A considerable number of bolls were examined, but no insect injury of any kind was noted. Believing that the cotton boll weevil would attack this as a food plant, a number of the bolls and squares were mailed to the laboratory of the Bureau of Entomology at Dallas, Texas, for testing with live weevils. This material was not received in good condition, however, so the testing of the attraction of the Arizona wild cotton for the typical *Anthonomus grandis* was deferred until the past summer.

The plant assumed economic importance when Mr. O. F. Cook made an announcement in February, 1913, of the finding of the Mexican cotton boll weevil in the bolls in Sabino Canyon, Santa Catalina mountains. This announcement was followed very shortly by the receipt at Washington of a sack of infested bolls from Stone Cabin Canyon, Santa Rita Mountains. Out of a total of 743 bolls, 220 weevil stages were obtained. Of these, 171 were dead but 18 live adults were found in their cells. In the bolls the mortality was provisionally classified as follows:

	<i>per cent</i>
Due to climatic causes.....	65.00
Due to predators.....	2.27
Due to parasites.....	1.82
Due to fungus.....	8.63
Total for all classes.....	77.72

Among the parasites were found the traces of two specimens of a *Cerambycobius*. The remaining parasites were Braconids. The material also contained thirteen stages of a Lepidopterous boll feeder, of which one larva was found alive. A predaceous Coleopterous larva was also found.

During the last two weeks in August the authors made a thorough examination of the insects associated with this plant in several localities in Arizona. The lowest altitude at which the plant was found growing was about 2500 feet in Fish Creek Canyon, sixteen miles west of Roosevelt. In this section the plant is quite common not only on the side of the canyon a short distance above the bed but even on the top of the high plateau nearby at an elevation of approximately 3300 feet. Many squares, a few blooms and a few bolls were found on the plants in this section on August 19. No weevil indications could be found here.

On the following day a search was made for the wild cotton plant in one of the canyons near Roosevelt and in a side canyon which opens into Fish Creek Canyon, but no wild cotton plants were found. Judging from observations afterward made in the Santa Catalina and Santa Rita Mountains the authors would consider both of these canyons as likely places for the plant to occur.

Owing to the extensive cultivation of cotton in the Salt River Valley below this point a search has been made for the plant in Hieroglyphic Canyon and also in another canyon of the Salt River Mountains south of Phoenix, by Mr. E. E. Russell under direction of the Arizona State Entomologist's office. No trace of the plant was found. It is quite probable that the wild cotton exists somewhere nearer the Salt River Valley cotton plantations than Fish Creek but no search other than mentioned has yet been made.

From Phoenix we proceeded to Tucson which is on the mesa surrounded by mountain ranges. The presence of cotton at Tucson lent considerable importance to the conditions here. Within a few years cotton will be grown for twenty or thirty miles in the Santa Cruz Valley if conditions permit. North of Tucson and coming within a very few miles of the cotton fields already planted are the Santa Catalina Mountains. The plant occurs according to our observations and those of Professor Thornber in Pima, Ventana, Sabino, Bear and Soldiers Canyons in this range. We found the weevil in the second and Mr. Cook found it in the third. It no doubt will be found in the others. Joining these mountains on the east are the Tanque Verde and Rincon Mountains in both of which ranges the plant occurs. South of Tucson about thirty miles are the Santa Rita Mountains in which the wild cotton is common. We found it in Sawmill and Stone Cabin Canyons, with the weevil abundant. West of Tucson is a very dry unpromising range of mountains, the Tucson Mountains, in which we found

absolutely no signs of the plant. Outside of our records *Thurberia* is known also to occur in the Mule Pass, Chiricahua, and Huachuca Mountains, at Ft. Bowie, Davidson Springs and near Dagoon, Arizona, and in southwestern Chihuahua and Guadalajara, Mexico.

In altitude the plant occurs from 2300 (Fish Creek Canyon, Arizona) to 5000 feet. (Sawmill Canyon, Santa Rita Mountains, Arizona.) According to Mr. F. L. Lewton it occurs as high as 7000 feet altitude in Mexico. It is perennial, resembling the cotton plant so closely that it is locally known as wild cotton.

Entomologically *Thurberia* is a very interesting plant. The large nectary of the midrib on the underside of the leaves, the three nectaries at the base of the involucrel bracts, and the nectar of the flowers prove powerful attractions to insects. The tender foliage and the succulent buds and bolls furnish excellent insect food.

BOLL WEEVIL.

By far the most important species attacking the wild cotton is the boll weevil, *Anthonomus grandis*, var. *thurberiae* Pierce which is known to breed in the squares and bolls in Ventana and Sabino Canyons of the Santa Catalina Mountains, and Sawmill and Stone Cabin Canyons of the Santa Rita Mountains. It passes the winter spring and summer in cells in the bolls, emerging in August or as late as September 1 to begin attack on the new crop of squares and bolls. It hardly seems possible that the weevil can have more than two generations a year on this plant. The eggs are laid at the base of squares, and are covered by a transparent gelatinous scale upon which is usually a little clot of excrement. The eggs are elongate, often twice as long as wide. On August 25 in Stone Cabin Canyon no larvæ were found over one-fifth grown, although it is quite possible the weevil may develop earlier in the lower canyons. The first adults were bred from Stone Cabin Canyon bolls about November 10.

The adult weevils are robust and generally larger than the Mexican cotton boll weevil and one receives a very strong impression that he is dealing with a distinct species. The records made by Mr. Coad at Victoria, Tex., however, have proven the Arizona form to be conspecific with the cotton boll weevil. The typical *grandis* occurs at altitudes under 2000 feet, while *thurberiae* is found only at altitudes of over 4000 feet. The food plants are considered generically different by botanists. Geographically the two varieties are separated by hundreds of miles. The cotton weevil occurs in Cuba, Costa Rica, Mexico and the southern United States while *thurberiae* occurs in southern Arizona and also probably in the mountains of Mexico.

LEAF WORM.

Next in interest is *Alabama argillacea*, one full grown larva of which was found on *Thurberia* in Stone Cabin Canyon, while the species was also found on the extremely isolated patch of cotton at Tucson thirty miles distant to the north, and also in the cotton fields at Phoenix. This species is known to display a tremendous power of flight in its annual northward dispersion. The question of greatest interest is whether the mild winters of Phoenix and Tucson will enable it to hibernate in Arizona and be present for the next cotton crop. At Victoria, Texas, Mr. Coad experimentally fed *Alabama* larvæ on his *Thurberia* plants and in some experiments gave them a choice between cotton and *Thurberia* leaves but found that they fed on both and that they matured normally when fed on the *Thurberia*. On the other hand they did not seek the *Thurberia* naturally.

This insect occurs on cotton in South and Central America and the West Indies, and only comes into the United States in warm seasons. It has never previously been taken on any other food plant than cotton.

The absence of the cotton worm with the single exception noted, in the sections where the Arizona wild cotton was examined, indicates the improbability of the insect being indigenous to Arizona. The discovery of the insect upon cultivated cotton near Tucson the first season of its growth in that locality is almost positive evidence that the moths of this insect had reached Arizona by flight from points hundreds of miles to the south.

THE THURBERIA BOLL WORM.

The *Thurberia* boll worm is considered the most destructive of all the insects found attacking Arizona wild cotton. During the latter part of August the eggs of this Noctuid were very abundant in Stone Cabin Canyon in the Santa Rita Range and were also found in Sawmill Canyon a few miles distant, but in this latter locality they were noticeably scarce. In Ventana Canyon in the Santa Catalina Mountains one of the authors (Morrill) in company with Prof. G. F. Freeman on July 1, 1913, estimated that about a fourth of the old bolls attached to the plants had been eaten out by worms, undiscovered at that time. A single old boll similarly destroyed was found at Fish Creek Canyon in August. Further evidence of the wide distribution of the insect in Arizona exists in the eggs found upon the herbarium specimens of the National Museum from near Bisbee (probably in Mule Mountains) and from the Rincon Mountains. It is of interest to note that the first of these records is dated September 14, 1892.

The egg is pure white in color, truncate-conical in form, with crater like apical depression. Greatest diameter 0.79 to 0.83 mm. height, 0.79 to 0.8 mm.; diameter of entrance to apical cavity, 0.13 mm.; edges ragged. Surface of eggs marked with slightly depressed reticulations forming polygonal cells, small at base of the eggs and gradually increasing in size as the diameter of the egg decreases. About 52 cells occur around largest circumference and about 21 cells around smallest circumference. As the embryo develops the egg gradually becomes distinctly pinkish.

The pupa is robust measuring about 10 mm. in length, and 5 mm. in width. Its color is light brown with dark brown spiracles.

The full grown larva is about 25 mm. in length, 5 mm. in diameter and cylindrical in general form. The head and cervical shield are yellowish brown in color as is also the anal shield. The spiracles are jet black. Integument marked with a rather broad stripe of deep pink extending along each side of the body interrupted at the joints. This stripe shades to paler pink above. Dorsal organ greenish and conspicuous. Where integumental color is absent or pale the body fluid and internal organs give greenish tone. In the younger stages the larvæ are more distinctly pinkish in color and lack the green tinge.

The eggs are deposited exclusively, as far as observed, on the tips of the involucre bracts and of the leaf lobes. Of 40 specimens of eggs 35 were found to occur singly. The exceptions consisted of one group of three and one group of two eggs.

The larva does not eat the egg shell after emergence nor has it been found feeding except upon the squares and bolls. Into these parts it eats its way exhibiting feeding habits quite similar to those of the cotton boll worm (*Heliothis obsoleta*). The young larva eats into several of the squares and finally attacks a boll and finishes growth inside of one. No observations have been made showing the number of bolls a single larva may destroy. The stems which bear the damaged boll are fastened to the plant by a band of silk apparently spun by the larva as it approaches the boll. This is strong enough to hold the boll if the stem should become detached as it sometimes does, but it seems probable that there is some other purpose in this action. The entrance to the cotton boll is made almost invariably near the base between the bracts. It is 2.25 and 3 mm. in diameter in the specimens observed.

When placed together the worms do not show cannibalistic tendencies. Sixteen out of nineteen worms under observation removed from the bolls which they had completely eaten out, burrowed into the ground without hesitation. Pupal cells thinly lined with silk were constructed at depths of from one to three inches below the surface. The *Thurberia* boll worms appear to

feed upon Egyptian cotton as readily as upon the wild cotton. One worm about one-half grown on October 2 was placed in a hole cut through the carpel of an Egyptian cotton boll and four days later it was noted that it had consumed two cotton seeds and having plugged up the artificial entrance hole with excrement it had made a new hole as an exit. In two instances larvæ about three-fourths grown were placed inside bracts of Egyptian cotton squares and ate out the interior of the flower bud in each case.

A few observations indicate the general similarity of the seasonal history of the *Thurberia* boll worm with that of the *Thurberia* boll weevil. No eggs or larvæ of the boll worm were found on July 2 in Ventana Canyon although the insects were abundant there as indicated by the large percentage of old injured bolls as noted above. The plants at that time were far advanced in their development as compared with other localities; squares and blooms were abundant and a few half grown bolls were seen. On August 25 in Stone Cabin Canyon it was estimated that 50 per cent of the eggs of the *Thurberia* boll worm had already hatched. Pink lepidopterous larvæ associated with these eggs, and now known to be the young boll worms, were found boring into the squares of the wild cotton plant. The worms found were in no case of greater length than 10 mm. and were therefore less than one-half grown. On September 1 worms of full size were found in the Ventana Canyon by Messrs. Pierce and Thornber and on October 1, Dr. O. C. Bartlett collected in the same canyon 24 boll worms of which 18 were full grown, four about three-fourths full grown, one about one-half grown and one about one-third grown.

After reaching full size the worms apparently remain for a considerable period inside the empty boll, but as far as observed they do not pupate there. Specimens which went into the ground and pupated during the first ten days of October have not yet (November 15) emerged.

Dr. Dyar, who has examined the larvæ finds that they resemble those of *Sacadodes pyralis* Dyar, the pink boll worm of cotton in Trinidad.

BLISTER MITES.

In the Santa Rita and also the Santa Catalina Mountains we found quite commonly a blister mite of the genus *Eriophyes*, to be described as new by Mr. Banks. The tiny eggs of this species are found in clusters like raspberries on the foliage in August. The mites are so numerous that their feeding causes the surface of the leaf to take on a fuzzy brown appearance. In Ventana Canyon many plants were found killed or almost so by this species which was abundant on both sides of every leaf and on the stems and

squares. It is of interest to note that a mite of this genus (*Eriophyes gossypii*) attacks cotton in Montserrat, St. Vincent, and St. Lucia of the West Indies.

LEAF GALL.

A species of Itonididæ (Cecidomyiidæ) is very common upon the plants in Stone Cabin Canyon. This insect oviposits in the midribs of the tiny leaves causing the leaves to form a sort of pocket-gall, but not preventing the leaf from completing its growth somewhat deformed. Within the walls of this gall the larva feeds. We have no Itonidid enemies of cotton in the United States but in the West Indies, *Contarinia gossypii* does considerable damage.

MEALY BUG.

A species of mealy bug (*Pseudococcus* sp.) was found on *Thurberia* near McCleary's Ranch in Stone Cabin Canyon on August 25. Between 20 and 25 specimens in all were collected and observed including two specimens of adult females. These insects were in most instances found inside rolls of the leaves evidently produced by the Itonidid maggots which are mentioned above. One of the full grown female specimens confined in a box without food gave birth to between fifteen and twenty larvæ within twelve hours. The two adults and several specimens one-half to three-fourths grown were kept in vials and fed upon *Thurberia* squares hoping to breed a sufficient supply for study. Later (after September 3) the insects were fed on Egyptian cotton squares at Phoenix. In all about fifty specimens were cared for but notwithstanding daily attention no more adults were bred and the mature females soon died.

It is suspected that the wild cotton mealy bug is the same as that found on *Gartneria xanthocarpa* in Pima Canyon on August 23 and that the same species was found on *Thurberia* in Ventana Canyon on August 31. On October 1, Mr. O. C. Bartlett was unable to find any additional specimens on wild cotton in Ventana Canyon.

The following notes were made concerning the adult specimens: Length 5.5 mm., width 3 mm., color shining dark gray. Short marginal ribbons of wax increasing slightly in length, posteriorly. No conspicuous marginal spines. Newly born larvæ quiescent with wax filaments from the body of the adult among them making a loose cottony mass.

In one vial containing an adult female and larva mass a dipterous pupa appeared. This was bred out and proved to be a species of *Leucopis*.

Mr. Coad was able to carry this mealy bug on cotton leaves at Victoria for a month.

MISCELLANEOUS INSECTS BREEDING ON THURBERIA.

A very tiny leaf miner was found quite abundantly in all of the places where we found the plant. This species has not yet been bred, but is quite different from the ordinary cotton leaf miner.

A new species of *Bucculatrix* was found feeding on the leaves of *Thurberia* in all the places investigated, and at McCleary's Ranch in Stone Cabin Canyon, this species had found the three or four plants which had been grown there at an altitude of about 4000 feet. The tiny larva of this species spins an elongate white corrugated cocoon less than $\frac{1}{4}$ inch long. The species will be described by Mr. Busck. Specimens of this genus have been found on cotton in Mexico.

Another Lepidopterous larva, determined by Mr. Busck as *Dichomeris deflecta* Busck, makes a fold in the leaf by means of two or three silken threads, and feeds within this fold. It is very active and when its hiding place is disturbed quickly slips out. It pupates in its fold. It fed on cotton at Victoria, but Mr. Coad could not carry it through to maturity. It is parasitized by a species of Braconidæ.

A species of Geometridæ was very commonly found feeding on the foliage of *Thurberia* in Stone Cabin Canyon. Geometridæ are commonly found on cotton.

One beautiful yellow and brownish Bombycine larva was found feeding on a *Thurberia* plant in Stone Cabin Canyon. This was successfully bred by Mr. Coad and determined by Dr. Dyar as *Lirimiris truncata* H. S., a species new to the United States.

A species of *Ephestia* breeds in the bolls quite commonly. Only one specimen has so far been carried to maturity. This was determined by Dr. Dyar.

A very pretty yellow *Spilochalcis* was bred in May from bolls infested by the *Ephestia*, and is very probably a parasite of it.

Two species of Thysanoptera were found in *Thurberia* flowers. Several specimens of *Frankliniella insularis* Franklin, (*Euthrips*) determined by A. C. Morgan, were found in a flower in Stone Cabin Canyon. This species occurs in Mexico, at Brownsville, Texas, and in Barbados.

A Ptinid, *Prostephanus truncatus* Horn breeds abundantly in the dead stalks. One Cerambycid stalk-boring larva was also found in Stone Cabin Canyon.

A Scutellarid, *Aulacostethus marmoratus* Say was found commonly feeding and breeding on dead bolls of *Thurberia*.

Twice in Stone Cabin Canyon a species of Eucharidæ was observed ovipositing in apparently healthy squares. In one instance the sprig was gently plucked and transferred to a vial without disturbing the tiny insect and both of us observed its ovipositor in-

sented in the square. This specimen is described as a new species of *Chalcura* by Mr. Crawford.

At Victoria, Texas, Mr. Coad's *Thurberia* plants became heavily infested by *Aphis gossypii*,

MISCELLANEOUS VISITORS.

The majority of the miscellaneous insects visiting this plant were present for its nectar although some were predatory.

The Hemiptera should probably be included among the injurious insects, but no definite records of feeding were obtained against those not already mentioned. An *Aleyrodes* in the winged form was occasionally seen. Mr. Heidemann has determined the following species taken in Stone Cabin Canyon: *Lygus bicolor* H. S., *L. lateralis* Dall, *Dendrocoris arizonensis* Barber, *Corizus punctatus* Signoret, *Notocyrtus* sp. and *Creontiades rubrinervis* Stal. From *Thurberia* in Pima Canyon we obtained *Lopidea confluent* Say and an *Empoasca*. A *Zelus renardii* Stal was collected in Ventana Canyon.

One small brown female Mantis, *Litaneutria obscura* Scudder, and two species of grasshoppers, *Barytettix neomexicana* Scudder, and a *Schistocerca* found only in nymphal stages, were taken in Stone Cabin Canyon, and the *Barytettix* was also on the plant in the Santa Catalina Mountains. These insects were determined by Mr. Caudell.

The following beetles determined by Mr. Schwarz were collected on *Thurberia* at Fish Creek, *Scymnus ardelio* Horn, two species of *Attalus*, one of them new, *Petalium bistriatum* Say and *Lema balteata* Le Conte. In Stone Cabin Canyon we took *Scymnus ardelio* Horn, *Hippodamia convergens* Guérin, *Thalassa montezuma* Mulsant, *Cryptorhopalum pumilum* Casey, *Chauliognathus profundus* Le Conte, and *C. obscurus* Schaeffer, *Enoclerus abruptus* Le Conte, a species of *Hydnocera*, *Hymenorus rotundicollis* Casey, and *Epitragus fusiformis* Casey. This last mentioned species and the *Chauliognathus profundus* were very common on many plants.

Three species of *Bruchus* were found at the nectar in Stone Cabin Canyon, *Bruchis impiger* Horn, *B. amicus* Horn and *B. chiri-cahuæ* Fall. In Pima Canyon *Bruchus crenatus* Schaeffer was collected.

Among the visitors at the nectar in Stone Cabin Canyon were three species of weevils, *Cyphus lautus* Le Conte, *Coleocerus dispar* Horn and *Lemosaccus texanus* Schaeffer.

The Hymenoptera were abundant visitors at the nectaries and pollen. The bees have been determined by Messrs. Cockerell and Crawford, the ants by Dr. W. M. Wheeler, the wasps by Mr. Rohwer.

The ants were constant visitors on the plants. The following species were taken; *Myrmecocystus melliger* Forel, subsp. *orbiceps* Wheeler, *Formica rufibarbis* Fabricius var. *gnava* Buckley, *Cremastogaster opaca* Mayr var., *Camponotus bruesi* Wheeler, *Camponotus fallax* Nylander var., *Camponotus mina* Forel. subsp. *zumi* Wheeler var., and two species of *Pheidole*.

Among the bees were *Melissodes communis* Cresson and *Perdita mentzelianum* Ckll. and a new species in each of these genera, and *Halictus mesillensis* Ckll. Professor Cockerell's notes follow this paper.

Mr. Crawford has determined the chalcids and finds seven species probably all undescribed. Two of these he presents in an accompanying paper. The yellow *Spilochalcis* and the *Chalcura* have already been mentioned. A beautiful black *Spilochalcis* was also taken in Stone Cabin Canyon, and in this same locality was found a species of *Habrocytus*. In Fish Creek Canyon we found a new species of *Perilampus*, a *Conura*, and a new species of *Rileya*, described in the accompanying paper.

Mr. Rohwer has determined the wasps to be a new species of *Tiphia*, two species of *Paratyphia*, and has also determined a Braconid of the genus *Monogonogastra*. A specimen of *Polistes bellicosus* Cresson was taken at nectar and was found to be parasitized by a *Xenos*.

Outside of two notices of the boll weevil on *Thurberia*¹ this is the first paper in which any insects are recorded from the plant. It is therefore of interest to note that this paper mentions 83 different species in 8 orders of Insecta and one of Acarina. The species are distributed as follows, Acarina 1, Hemiptera 14, Orthoptera 3, Thysanoptera 2, Lepidoptera 7, Coleoptera 24, Hymenoptera 29, Diptera 2, and Strepsiptera 1.

These insects may be classed as injurious 25, nectar visiting 40, parasitic 12, and predaceous 6, in their purposes of visiting the plant.

STUDIES OF THE ARIZONA THURBERIA WEEVIL ON COTTON IN TEXAS.

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In order to establish the taxonomic status of the weevil breeding in Arizona in the squares and bolls of *Thurberia thespesioides* a number of studies have been undertaken. In connection with these studies individuals of both sexes of the Arizona and Texas

¹ Cook, 1913, Science, February, 1913.

Pierce, 1913, The occurrence of cotton boll weevil in Arizona, Journ. Agr. Research, 1, no. 2, pp. 89-96, pl. vi.